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Impact of Process Temperature, Humidity, and Initial Product Moisture on Thermal Inactivation of *Salmonella* Enteritidis PT 30 on Pistachios during Hot-Air Heating

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ABSTRACT

Some thermal processes, such as pistachio roasting, are not yet well characterized with respect to the impact of product and process variables on *Salmonella* lethality. This study aimed to quantify the effects of process temperature, humidity, and initial product water activity (a_w), on *Salmonella* lethality for in-shell pistachios. In-shell pistachios were inoculated with *Salmonella* Enteritidis PT 30 (~8.5 log CFU/g), equilibrated (0.45 or 0.65 a_w), and heated without soaking ("dry") or after a pure-water or 27% NaCl brining pretreatment ("presoaked"). Inoculated pistachio samples (15 g) were heated in a laboratory-scale, moist-air convection oven at 104.4 or 118.3°C, humidities of ~3, 15, or 30%, v/v (~24.4, 54.4, or 69.4°C dew point), and air speed of 1.3 m/s. *Salmonella* survivors were quantified at six times during each treatment, targeting total reductions of ~3 to 5 log. Survivor data were analyzed using analysis of variance to identify main effects (time, temperature, humidity, and initial a_w)

and two-term interactions with time. As expected, lethality increased ($P < 0.05$) with temperature and humidity. For example, the time to achieve a 4-log reduction decreased 50 to 80% when humidity increased from ~3 to 30%. When the dry and presoaked treatments were analyzed separately, initial product a_w (0.45 versus 0.65 a_w or 0.75 versus 0.95 a_w) did not affect lethality ($P > 0.05$). However, when comparing dry against presoaked treatments, the time to achieve a 4-log reduction decreased 55 to 85% ($P < 0.05$) for presoaked pistachios subjected to the same temperature-humidity treatment. Salt had no effect ($P > 0.05$) on lethality outcomes. These results, relative to initial a_w, process humidity, brining, and salt effects on process lethality, are critically important and must be considered in the design and validation of thermal processes for *Salmonella* reduction in pistachio processing.